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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

QUESTIONS AND ANSWERS ON STORAGE OF COAL IN THE ROCKY MOUNTAIN AREA[1]

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Who should store coal and why?

Under the present emergency every consumer should store as much coal as he can. Although there is no shortage of coal, there is likely to be a shortage of labor to mine excessive quantities in the fall, and railroads cannot be expected to deliver coal promptly on account of the need for transporting war materials.

Some miners must join the armed forces, and those who are left may be unable to mine coal as rapidly as you will need it when winter comes. When the first cold days arrive, there may be a shortage of trucks to deliver coal. Deliveries may be planned in advance, and your turn might not come until it is too late.

What other advantages are there if I store coal?

If mines can work steadily you might get your coal for less money, and possibly some arrangement will be made at your bank so that you can pay for the coal in the fall and still pay less for it.

I am a home-owner - what kind of coal should I store?

If you fire your furnace by hand, lump coal is the best kind for burning and storage. Ask your dealer for screened lump larger than 2-1/2-inch size. He will be pleased to sell you the best lump coal at a reasonable price because if you don't buy it he may have to crush it to sell to a factory that wants slack. He crushed a lot of lump coal last year during the summer and sold it for less than lump prices; that is one reason why you have to pay higher prices for lump coal when you order it at your convenience in the winter. It pays you to buy lump coal in the summer.

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7214."

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You can store nearly any kind of clean lump coal in your furnace room without any loss or danger, especially if you close the bin up tight. Most of the coal sold in the West contains 5 to 23 percent water when it is delivered to you. Water does not burn, and if some of it evaporates during the summer, you might get more heat out of the coal during the winter. The heating value does not decrease during 4 or 5 months under good storage conditions.

If you have a stoker, follow your dealer's advice. He will probably advise you to store oil-treated bituminous stoker coal, which will give you no trouble. Small-size lignite does not store as well as bituminous, and you might have some trouble with dust.

How much coal will my bin hold and what precautions should I take?

If you store lump coal, your bin will hold 40 to 50 pounds to the cubic foot, depending on the mixture of sizes in the delivered coal. An 8- by 10-foot bin filled 6 feet deep with lump coal will contain 480 cubic feet or about 10 to 12 tons.

Examine the bin before delivery is made. Clean out all dust, and repair the walls to make them as airtight as possible. A retaining partition just back of the bin door is recommended. This will prevent coal falling through the door, and more coal can be stored in the bin. The lower part of this partition should be removable to permit the coal to be reached with a shovel when you start the furnace. When the coal is delivered, request the driver to level off the coal in the bin as far as practical, then close the bin as tightly as possible. Coal having high initial moisture stores better if the bin is not ventilated.

Oil-treated stoker coal will weigh about 47 to 53 pounds to the cubic foot. Follow the same precautions as above.

Remember, you will have no trouble if your bin is tight and cool. If your bin is not tight or is not a completely isolated room, it will pay you to make it tight. Nearly all troubles experienced when storing coal in a home can be traced to a poor bin which is not tight.

I am a small industrial consumer - what kind of coal should I store?

You burn coal all summer, but you probably burn more in the winter than in the summer. Therefore, you should see to it that your coal bins are full before September 30. You probably burn slack coal, which is harder to store than clean lump and requires more care and attention to avoid trouble. The average weight of 2-1/2-inch slack coal in Colorado is 49 pounds per cubic foot and ranges from 46 to 52 pounds.

You will probably continue to buy slack because it is cheaper. Generally speaking, coal in this area having the highest heating value is the best coal to store; you will have the least trouble with it, and you can store more heat value in a given space. Usually, coal dealers sell coal of higher heating value for a higher price per ton, but if you figure it out, the actual cost to you of the heat may be the same, and is sometimes less, than the cost for lower-heating-value fuel. Higher-heating-value coal has less water in it when delivered, and it stores better. Therefore, you should shop around and get the highest heat value in the coal you intend to store. Ask your dealer - he will tell you the heating value of the coal he sells. If he does not know, then ask the Bureau of Mines, whose engineers know and will tell you quickly. A letter to the Bureau of Mines, Golden, Colo., or Washington, D.C., will give you the estimated heating value of coal from any mining field in Colorado, Utah, Wyoming, or New Mexico.

What precautions should I take?

Repair your bin and make it as airtight as possible - especially the sidewalls. Enclose it entirely if possible - this will reduce any troubles. Clean out old coal dust, rags, or other refuse.

Keep the pile leveled off, and avoid segregation of different sizes by mixing fine coal with coarse coal. This precaution keeps air circulation down, and your coal will store better.

Move or thoroughly insulate any hot steam pipes that may be in the coal bin.

Avoid storing slack coal deeper than 10 feet. This will reduce the possibility of spontaneous combustion, which sometimes occurs when slack coal is stored.

If you can afford it, buy coal that has been screened to remove the fine dust. It will store better than dusty coal.

What is spontaneous combustion, and what causes it?

When coal is mined it becomes exposed to the oxygen of the air for the first time in millions of years. All coals want to absorb oxygen, but some take up oxygen more quickly than others, and all coals absorb oxygen more quickly just after they are mined than later on. Some heat is formed when oxygen goes into coal, but it is so slight that ordinarily it is not noticed. However, when coal is in a large pile, the heat cannot escape, and it builds up until the spot in the coal pile is hot enough to start burning; that is spontaneous combustion. Fine coal oxidizes faster than lump coal.

If you keep air from circulating in the coal and if you pile the coal only 10 feet deep and keep it cool, experience shows that no spontaneous combustion will occur. That is why it is best to store coal in tight bins, to keep the pile leveled off, and to mix up the sizes when storing.

Suppose my bins are not big enough, and I want to store 200 or 300 tons so that I will be sure to have enough coal to last me all winter?

This is a good idea, and you can store that amount of coal without much cost or worry. It will pay you to store only the highest-heating-value bituminous coal if you can get it at a reasonable price. You can store 200 or 300 tons of good bituminous coal in a pile outside with minimum trouble.

Three hundred tons of slack coal, when piled 10 feet deep, will occupy an area of about 30 x 65 feet on level ground. A portable conveyor fed from dump trucks will place the coal in storage. These are used in many large coal yards and might be borrowed or rented. It is a good idea to avoid piling the coal too high in one place. This causes segregation, and the larger lumps fall to the outside while the fines concentrate in the center. Level off the pile into 3- or 4-foot benches, and this segregation will be minimized. The coal can be retrieved from the pile and placed in a truck or wagon by the same method used in storing it.

I am a large industrial consumer - what kind of coal should I store?

You probably have bought coal upon a fuel-value basis for many years, and you know what coal is most economical for your operations. On account of costs, it might not be practical for you to buy coal having the best storing properties. Furthermore, you are concerned with storage of large quantities, which must be available when you need them. You might also be concerned about delivery of coal to your plant, even if you do store as much as possible. Therefore, your experience in the use, purchase, and storage of coal might be given freely and profitably to smaller consumers who know less than you. Encouragement by actual help to smaller consumers on handling and storing coal for their needs will give greater insurance for deliveries to your plant during the winter.

We can go further into technical details when discussing problems connected with storage of larger quantities of coal:

What are a few good rules to remember when storing coal?

1. Select the highest grade of coal that you can afford. In general, store bituminous coal having the highest heating value.

2. Store in a tight bin, particularly one with tight sidewalls. This reduces circulation of air in the pile and will minimize troubles.

3. If you store lump coal, keep the breakage resulting from handling mixed with the lumps and avoid segregation. The big lumps will help cool the little lumps if there is a tendency toward heating.

4. If you store slack coal, place it in storage in a series of benches leveled off. This will help keep down circulation within the pile. Packing the coal with a roller or caterpillar tractor gives much improvement in this regard.

5. If you detect an odor of smoke coming from the pile, investigate and plan to move part of the pile as soon as practical. Drive a piece of pipe into the questionable spot - if it is warm when it comes out it might be best to start moving the coal. When temperatures inside a mass of stored coal reach 150°F., spontaneous combustion is proceeding at a rapid rate.

6. It is not a good plan to store slack coal deeper than 10 feet in an enclosed bin unless the bin is made of fire-resistant material or concrete. Slack coal can be stored 20 or 30 feet deep in a cool, closed concrete bin without danger.

What is the average heating value of various coals mined in the West?

The following table gives the average range of heating value of delivered coal:

State	Mining field	Class of coal	Average range heating value as received, B.t.u. per pound
Colorado	Routt	Bituminous	11,000 to 12,100
Do.	North Park	Subbituminous	9,100 to 10,300
Do.	Denver	do.	9,200 to 10,500
Do.	El Paso	do.	8,000 to 9,400
Do.	Trinidad	Bituminous	12,500 to 13,500
Do.	Walsenburg	do.	11,600 to 13,000
Do.	Glenwood Springs	do.	10,500 to 13,800
Do.	Crested Butte	do.	13,000 to 13,400
Do.	Somerset (Paonia)	do.	11,000 to 13,200
Do.	Grand Junction	do.	11,000 to 12,700
Do.	Durango	do.	11,800 to 13,800

State	Mining field	Class of coal	Average Range heating value as received, B.t.u. per pound
New Mexico	Raton	Bituminous	12,000 to 13,000
Do.	Gallup	Subbituminous	10,500 to 12,000
Do.	Los Cerrillos	Bituminous	12,500 to 13,200
Utah	Carbon County	do.	12,500 to 13,400
Do.	Coalville	Subbituminous	10,200 to 11,000
Wyoming	Sheridan	do.	9,000 to 9,900
Do.	Hanna	do.	10,500 to 11,500
Do.	Rock Springs	Bituminous	10,500 to 12,700
Do.	Kemmerer	do.	11,200 to 13,300
Do.	Gillette	Subbituminous	8,000 to 8,800

What about storage of large quantities of coal for stand-by or reserve?

Large public utility power plants, coke plants, and other large consumers of coal usually store reserve supplies to meet an unexpected emergency. This practice might be extended to other consumers who have not taken this precaution. For instance, educational institutions, manufacturing plants, or other steady consumers of fuel would ease the expected emergency by putting in a reserve supply near their heating plant, which could be used if necessary in case of emergency.

A large power plant in Texas stores thousands of tons of lignite in open pits for emergency use. An earthen pit 20 to 30 feet deep, with tight sidewalls, is filled with lignite and the top is leveled. This is a very cheap method of storing reserve fuel. Spontaneous combustion does not occur because all air is excluded from bottom and sides.

Sugar factories store about 100,000 tons of subbituminous coal under water each year. It is estimated that the cost of storing under water is 20 to 50 cents a ton, depending on the cost of the pit. This assumes the pit will be used for a long time.

The highest-quality coking coal can be stored in piles on level ground with little danger from loss by spontaneous ignition. The lower-heating-value fuels cannot be stored in this manner on account of weathering, degradation, and loss from spontaneous combustion.

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When large quantities of slack are stored in the ground, the safest procedure is to place the coal in leveled layers followed by close packing with a caterpillar tractor or similar machine.

Probably the cheapest and most satisfactory way to store 1,000 tons of any kind of coal as a reserve supply for industrial use, would be to place it in an open earthen pit. About 1,000 tons of slack coal will fill a pit having a capacity of 42,000 cubic feet or one measuring 65 feet square by 10 feet deep.

Observations are now being made by the Bureau of Mines on storage of 200 tons of subbituminous coal in an open concrete pit. The coal is leveled to a depth of 6 feet. After 1 month of storage there has been no indication of trouble, and the probabilities of trouble decrease as the period of storage increases, because smaller amounts of oxygen are absorbed.

SELECTED PUBLICATIONS OF THE BUREAU OF MINES ON STORAGE OF COAL

*Technical Paper 170. The Diffusion of Oxygen Through Stored Coal, by S. H. Katz. 1917. 48 pp., 1 pl., 27 figs. 10 cents.
Discusses experiments to determine the effects of size of coal pieces and proportion of voids in a coal pile on the rate at which oxygen can travel by diffusion from the air around the pile of coal to within.

*Technical Paper 235. Safe Storage of Coal, by H. H. Stoek. 1940. 10 pp. 5 cents.
Discusses the advantages of storing coal and points out precautions to be observed.

*Technical Paper 326. Fires in Steamship Bunker and Cargo Coal, by H. H. Stoek. 1923. 52 pp., 4 figs. 10 cents.
Presents data of interest to steamship owners and to shippers and buyers of water-borne coal.

°Report of Investigations 3587. Storage of Subbituminous Coal in Bins, by V. F. Parry and John B. Goodman. 1941. 10 pp.

°Bulletin 136. The Deterioration of Stored Coal, by H. C. Porter and F. K. Ovitz. 1917. 38 pp., 7 pls.
Covers the results of storage for 5 years, under widely different conditions, of samples of coal from Pennsylvania, West Virginia , and Wyoming , shows small loss of heating value of bituminous coal during storage.

°Technical Paper 16. Deterioration and Spontaneous Heating of Coal in Storage, a Preliminary Report, by H. C. Porter and F. K. Ovitz. 1912. 14 pp.
Superseded by Bull. 136 and T. P. 170, 235, and 326.

°Technical Paper 65. A study of the Oxidation of Coal, by H. C. Porter and O. C. Ralston. 1914. 28 pp., 12 figs.
Discusses the physical-chemical reactions between oxygen and coal substance.

*Technical Paper 409. Spontaneous Heating of Coal, by J. D. Davis and D. A. Reynolds. 1928. 74 pp., 20 figs. 20 cents.
Presents assembled results of investigations made by the Bureau of Mines and their correlation with those of other investigators. Gives a critical review stressing the more recent laboratory studies on spontaneous combustion.

See footnotes on next page.

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'Report of Investigations 2109. Safe Storage of Coal, by H. H. Stoek. 1920. 8 pp.
Questions and answers on coal storage, grouped by quantity to be stored.

†Information Circular 7074. Spontaneous Combustion of Coal, by O. P. Hood. 1939. 5 pp., 8 figs.
Gives a brief discussion of the factors involved.

†Information Circular 7211. Pointers on The Storage of Coal, by J. F. Barkley. 1942. 5 pp. 4. Figs.
General Discussion.

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*May be purchased at price named from the Superintendent of Documents, Washington, D. C.

'Out of print. May be consulted at libraries.

-Obtainable without charge from Bureau of Mines, Washington, D. C.